



# LIGHT AND MATTER

A NEW CLASSICAL THEORY OF LIGHT AND  
MATTER BASED ON THE MAXWELL EQUATIONS  
AND THE SPECIAL RELATIVITY THEORY WITH  
CRITICISMS OF THE EXISTING THEORIES

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## PREFACE TO THE FIRST EDITION

My paper, *A New Classical Theory of the Photon and the Electron* was published in Vol. XII, No. 6 of the PROCEEDINGS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA in August, 1946; a short summary had been published in SCIENCE AND CULTURE of January, 1946. Though prints were widely distributed among the leading physicists, the learned societies and the scientific journals of India, Europe and America with an open invitation for comment and specific criticism, the response was disappointing. A few courteous acknowledgments were received but no criticism, constructive or destructive.

In the present booklet, the objections to the current theories have been explained in greater detail, supported by extensive quotations from well-known authorities, and the main thesis itself has been expounded more fully. It has been my endeavour to present the case against the existing theories and formulate the new theories in as readable a form as possible. The mathematics is fairly simple and will, it is hoped, be intelligible even to those physicists whose mathematical equipment may not be high.

It may be stated here that the thesis has no conflict with Quantum Mechanics regarded from a statistical point of view, though there is a certain amount of divergence. Even if the present theory be accepted, Quantum Mechanics will not have to be scrapped, but will have to be re-written from a new standpoint.



I shall feel grateful for any comment or criticism which may be offered. Any expression of approval or suggestion for improvement will be doubly welcome. In any case, it behoves the Quantum physicists to meet the criticisms levelled against them. Truth is not served by ignoring criticism. I trust, however, that argument of the type "Fifty thousand Frenchmen cannot be wrong" will not be brought forward, either explicitly or by implication.

12, BALLYGUNGE CIRCULAR ROAD,  
CALCUTTA, 15th June, 1947.

B. M. SEN



## PREFACE TO THE SECOND EDITION

THE reception to the booklet has not been enthusiastic—not that there was any fault or defect found in the main arguments. Requests for comments and criticisms to physicists and scientific periodicals excited no response. But mere shaking of the head however wise is not criticism. Only one defect was pointed by the Editor of a well known journal, *viz.*, the assumption of the invariance of the electromagnetic vector under Lorentz transformation, while the invariance of the Maxwell equations was the proposition proved. But when the lacuna was filled in a subsequent paper, the journal refused its publication as unsuitable! The fact is that those who would be judges are themselves deeply committed to the current theory. Naturally they are loath to accept the challenge and enter into arguments. One sympathetic physicist offered the consolation that Mendel's work was recognised fifty years after his death!

The only gesture of encouragement which is gratefully acknowledged came from a mathematician, Prof. Birkhoff who as Chairman of the International Congress of Mathematicians at Harvard in 1950, recommended my name for a special invitation. But the invitations had gone out and there was no vacant place. I received also invitations from the International Congress of Mathematicians at Amsterdam in 1954, and from the Seminars for Theoretical Physics in Aachen, Heidelberg, Cambridge and the University College, London. I thank the authorities for the courtesy.

In the circumstances, all that I can do is to embody the results obtained and leave the matter to the judgment of posterity. My three objections to the Einstein principle  $E=hf$  which is the basis of modern physics are still unanswered. They are:

(i) a divisible beam with an indivisible quantum of energy is a contradiction in terms, (ii) the theory that light behaves as a particle or a wave just to suit experimental needs, introduces the supernatural in the domain of natural philosophy, (iii) the existence of the continuous spectrum implies infinite radiated energy. These are logical defects and until they are answered, modern Physics can only be regarded as empirical, all its successes notwithstanding. The supposed verification of any theory is not always a reliable indication of its truth as has been proved in the case of Dirac's prophecy of the positron and Yukawa's of the meson. The scope of modern experimental physics is so vast that it is a very complicated jigsaw puzzle to formulate a theory to fit all known facts.

In this edition the booklet has been revised and in places, the arguments amended. Once again I invite comments and criticisms.

12, BALLYGUNGE CIRCULAR ROAD,

CALCUTTA—19.

7th May, 1958

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## CHAPTER I

### THEORIES OF LIGHT—HISTORICAL AND CRITICAL

I. The various theories of light—the elastic solid theory of Fresnel and Young, the electromagnetic theory of Maxwell, the quantum theory of Planck and Einstein and the wave theory of Schrödinger, Heisenberg and Dirac—have one characteristic in common. They all emphasise their successes and pass lightly over their difficulties. Like the proverbial curate's egg, they are all good in parts. To get a clear concept of their failures and difficulties it is necessary to recount them with special emphasis. This is a necessary preliminary before the formulation of the successful theory.

When a theory does not explain, or if it runs counter to, facts of experiment, the usual practice in the scientific world is, or at least ought to be, to hold the theory in suspense until such difficulties are cleared. When any theory contradicts a generally accepted principle, the only logical procedure is to give up either the theory or the principle. But in present day physics, all the theories are accepted, each reigning supreme in its own limited sphere though contradicting the others in fundamentals. All efforts at co-ordination have had no marked success. The correspondence principle, seeking to bridge the gulf between the classical theory and the quantum theory,



accepting the former when convenient and rejecting it in other cases, without reconciling the fundamental concepts, has added to the confusion of the entire position. Modern physics has very conveniently forgotten the fundamental principle of logic that no theory may be half right and half wrong. There are no tight compartments in the brain for different physical theories.

2. As is well known, the elastic solid theory is eminently successful in the region of Physical Optics, though the fundamental assumption about the nature of production of light waves, *viz.*, vibration of electrons in an elastic solid medium dragging the jelly-like material after themselves, has long been given up. The facts of Geometrical Optics, reflection and refraction, are explained by any wave theory and those of Physical Optics—polarisation, interference and diffraction—are all explained simply and apparently conclusively by the elastic solid theory. It put itself into a practically impregnable position for those times (the end of the eighteenth century) by discovering and explaining diffraction and thus overcoming Newton's objection that waves must be capable of bending round straight edges, which apparently light waves cannot do.

But the theory fails abjectly when the energy of such waves is considered. For interference, it is essential that the same single beam must be divided into two components which are made to recombine after one of them has been retarded by half a wave-length. It is a matter of common experience that two separate beams cannot be made to interfere. But the energy of a beam, according to the

elastic solid theory, is proportional to the square of the amplitude of vibration. The amplitude of the original beam, on the other hand, is equal to the sum of the amplitudes of the component beams.\*

This means a violent clash with the principle of Conservation of Energy, with no means of escape. Unless physicists were prepared to give up the Principle of Energy, the only logical course would have been to regard the theory at least with some reservation. But curiously enough, this big difficulty is simply passed over and as far as our knowledge goes, no mention is ever made of it in any of the current text-books on Physical Optics. It is inconceivable that such an elementary and fundamental difficulty could have escaped the notice of physicists over so many years.

3. Maxwell's electromagnetic theory records a great achievement in establishing connection between several branches of Physics, light, electricity and magnetism hitherto regarded as absolutely independent of one another. Its main contribution is to specify the nature of the light waves while accepting in a vague way the explanations of

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\* A physicist friend has pointed out that the amplitude of the original beam is equal to the vector sum of the amplitudes of the component beams and that a difference of phase is introduced by reflection. We have considered here the amplitude at the instant of separation of the two beams before the reflection actually takes place. Also vector addition does not bar out scalar addition which is a special case. In any case, it is not worth while to examine the point more thoroughly, as the theory itself has been given up, except for college teaching.



Let us consider a plane wave of frequency  $\nu$  and amplitude  $A$  travelling in the  $x$  direction. Let us assume that the wave is polarized in the  $xy$  plane. At any point  $x$  the electric field is given by  $E = E_0 \sin(kx - \nu t)$  and the magnetic field by  $B = B_0 \cos(kx - \nu t)$ . The energy density  $U$  is given by  $U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 B^2$ . The energy flux  $S$  is given by  $S = \frac{1}{\mu_0} E \times B$ . The energy density  $U$  and the energy flux  $S$  are related by the equation  $S = cU$  in a free medium.

$$U = U_1 + U_2$$

Let us now consider a plane wave of frequency  $\nu$  and amplitude  $A$  travelling in the  $x$  direction. Let us assume that the wave is polarized in the  $xy$  plane. At any point  $x$  the electric field is given by  $E = E_0 \sin(kx - \nu t)$  and the magnetic field by  $B = B_0 \cos(kx - \nu t)$ . The energy density  $U$  is given by  $U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 B^2$ . The energy flux  $S$  is given by  $S = \frac{1}{\mu_0} E \times B$ . The energy density  $U$  and the energy flux  $S$  are related by the equation  $S = cU$  in a free medium.

$$U^2 = U_1^2 + U_2^2$$

Let us now consider a plane wave of frequency  $\nu$  and amplitude  $A$  travelling in the  $x$  direction. Let us assume that the wave is polarized in the  $xy$  plane. At any point  $x$  the electric field is given by  $E = E_0 \sin(kx - \nu t)$  and the magnetic field by  $B = B_0 \cos(kx - \nu t)$ . The energy density  $U$  is given by  $U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 B^2$ . The energy flux  $S$  is given by  $S = \frac{1}{\mu_0} E \times B$ . The energy density  $U$  and the energy flux  $S$  are related by the equation  $S = cU$  in a free medium.

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$$k_1 \sin \theta_1 = k_2 \sin \theta_2 = k_3 \sin \theta_3$$

$$K_1 V_1 = K_2 V_2 = K_3 V_3$$

Let us now consider a plane wave of frequency  $\nu$  and amplitude  $A$  travelling in the  $x$  direction. Let us assume that the wave is polarized in the  $xy$  plane. At any point  $x$  the electric field is given by  $E = E_0 \sin(kx - \nu t)$  and the magnetic field by  $B = B_0 \cos(kx - \nu t)$ . The energy density  $U$  is given by  $U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 B^2$ . The energy flux  $S$  is given by  $S = \frac{1}{\mu_0} E \times B$ . The energy density  $U$  and the energy flux  $S$  are related by the equation  $S = cU$  in a free medium.





There is no clear indication how the theory of the reflection must be worked out. The reflection coefficient has to be deduced on the basis of the principle of conservation of energy. In the case of a surface that is rough, considerations are complicated. The theory of the reflection from a rough surface has proved to be a difficult task, and it is even difficult to extend the reflection theory in spite of the widespread anxiety that the equality should hold (H. p. 56).

On this subject he pointed out that if the Maxwell equations are applied for a dispersive medium, one ought to be a little cautious. The wave number is not uniform, whereas the phenomenon of dispersion does not affect the refractive index of a medium in a vacuum with the velocity of light. It is easy to show that the refractive index is not constant. The phenomenon of dispersion is supposed to conform to the principle of causality, and the refractive index is to be the index of the medium when the refractive index value is not constant, but for a wavelength of  $\lambda_0$  it has been deduced on the supposition that the medium is isotropic at every point (H. p. 525). In the Maxwell theory the dispersion mechanism is very obscure.

4. Towards the end of the nineteenth century many experiments have shown that the laws of conservation of energy was Planck's law, founded by the fact that the energy of a black body is proportional to the intensity of light is accounted for by the presence of the number of  $h\nu$  quanta in the incident beam.

Sommerfeld points the following passage from Planck's address at Heidelberg in 1889:





7. But the Einsteinian theory does not see an outline for the problem. The fact that it does requires that the same beam may be split up into two components. From a point of view of most theories in Quantum Mechanics one would not suspect that such a problem should exist. It seems to have been systemically ignored. But I will have to leave the following explanation.

Suppose we have a beam of light which is passed through a kind of interference experiment. It gets split up into two components and the two components go separately and independently. We may then have a coherent beam consisting of only a single quantum and inquire what will happen to it as it goes through the apparatus. This will present to us the difficulty of the conflict between the wave and corpuscular theories of light as an interference. We must now discuss the problem separately with each of the two components into which the coherent beam is split. The portion to be in a definite state of motion should not be associated with an entire beam of light, but may be associated with two or more beams of light which are the components into which an original beam has been split. (De Broglie, p. 7)

Such an argument concerning the quantum of energy in De Broglie's mechanism is certainly to be seriously considered, but it looks down at the most superficial criticism. What happens when the two component beams are widely separated by various factors? The quantum of energy cannot be present in both as it is more viable that the total energy is not reduced or withdrawn from the path of the beam. We must then have a beam of





Obviously, no amount of sophistry can explain the divisibility of a beam as required by the phenomenon of interference and retain the indivisible quantum of energy as enunciated by Einstein.

The same error has been added to some previous editions of this treatise in the chapter on Modern Physics. The recorded wave character of particles is not to be understood exactly as pointed out and there is no help, even now. The present view seems to be that light is both particle and wave. Its particle manifestation appears in the photoelectric effect and in the Compton effect. The wave aspect is manifested in the interference and diffraction experiments. It is set up as a contradiction to say that light is both waves and particles, but it is not a contradiction as appears when we observe a particle passing a certain point and a wave passing a certain point. It is as before, but the two phenomena must be taken into consideration of the same experiment. The same may be said to the behaviour of matter in experiments designed to investigate the diffraction of matter and matter. These phenomena of matter are not without exceptions, but they are perfectly understood in space conceived by quantum theory though the other. This of course is the language of the layman, not the man of science. The latter prefers to say that the laws of nature are not applicable to the particles and to the matter as a whole. The philosophical content of the two statements is completely identical (see page 1 p. 88).

The current theory about the dual nature of light is a very loose state of being picture. Here De Broglie's theory is not satisfying but not at all a previous one.











cannot be identified with the classical term classical considerations affect the problem. But finally, the law of conservation of intensity is quite differently different from that of conservation of energy, even in the case of the quantum theory of waves in motion as proposed by de Broglie, since it is impossible to measure and conserve it. Also, the appearance of the correspondence principle shows that the quantum principle does not include automatically the classical principle. Reichenbach's hypothesis and the quantum theory he put forward that the relation between Planck's theory of photons and the Newtonian theory of light is that of the relation between the classical theory of waves and the quantum theory of photons is not in contradiction with the fact that it Newtonian theory is in contradiction with it.

(c) The second expression of the hypothesis is that the conservation law of Heisenberg's uncertainty principle (Heitler, p. 113)

$$\Delta E \Delta t \approx h$$

is in contradiction with the conservation of energy and time, whether it is a law of conservation or a law proposed by the theory. Some observations and experiments are contrary to Quantum Mechanics and are incompatible with it. In fact, the theory of the frequency of waves is in contradiction with the quantum determination of the frequency of light. So, the light must be considered as the energy of the wave at the frequency. But this explanation shows the contradiction in the hypothesis of the conservation of energy. It offers a satisfactory explanation of



the fact that the Dirac- $\delta$  Solution, for example, is subject to other than many objections of the spectrum. It therefore may substantiate all these objections. **Einstein's relation (11) must be regarded as an over-generalisation,**

(11) Again Dirac defines a  $\delta$ -function as follows:

$$\delta(x) = 0 \text{ when } x \neq 0, \quad \int_{-\infty}^{\infty} dx \delta(x) = 1 \quad (\text{Dirac, p. 72})$$

This function plays a important role in Quantum Mechanics.

Logically, the integral does not make sense, for an integral must cover a stretch of the independent variable which is more than a single point. If we extend the definition by making  $\delta(x) = 0$  when  $x$  is not between  $x_1$  and  $x_2$  and then make  $x \rightarrow 0$ , it is easily verified that  $\delta(x)$  must exist. Let us suppose that the unknown integral of  $\delta(x)$  is  $f(x)$ . Then

$$f(x + \epsilon) - f(x - \epsilon) = 1$$

If we make  $x \rightarrow 0$ ,  $x \rightarrow \pm \infty$ ,  $f(x) \rightarrow 0$ ,  $f(x) \rightarrow 1$  with a jump discontinuity at the origin. It cannot therefore possess a definite limit at the origin. The  $\delta$ -function is therefore a  $\delta$ -value. Dirac himself has admitted that it is an improper function but that has not prevented it existing as a  $\delta$ -value, under the function in Quantum Mechanics.

We now come at last only to specific examples, such a function defined as follows (Dirac, p. 74):

$$F(x) = L \lim_{\epsilon \rightarrow 0} \frac{\epsilon}{\pi(x^2 + \epsilon^2)},$$



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Then  $q_1 = q_2 = 0$  for  $x > 0$ . For the  $x < 0$  part of the boundary the method of steepest descents follows

$$\int_{-\infty}^0 I(x) dx = \int_{-\infty}^0 \frac{I(x)}{c \rightarrow 0} \pi (x^2 + c^2)^{-1/2} = \frac{I(0)}{c \rightarrow 0} \pi \int_{-\infty}^0 \frac{dx}{x^2 + c^2}$$

$$= \frac{I(0)}{c \rightarrow 0} \pi \left[ \cot^{-1} \frac{x}{c} \right]_{-\infty}^0 = \frac{\pi}{2} \frac{I(0)}{c \rightarrow 0}$$

which is not usually permissible.

A few words may be added about the derivation of Sommerfeld's equation. He began the equation by a process of extrapolation of the expression for energy for wave motion at the boundary over the period to which it applies. He made frequency  $\nu$  a purely periodic variable and  $x$  a real distance partly real and partly imaginary. The unknown wave equation coefficients  $A$  and  $B$  in eq. (20) of *op. cit.* He called the stationary wave ground part of the wave and the  $\exp i k x$  foundation.

(2) As for the method of  $c \rightarrow 0$  it is not a new method but a method which has been used by other scientists. It is strictly a fully described mathematical method.

(3) Noncommutative mathematics which is one of the cornerstones of Quantum Mechanics has not presented any difficulty to the mathematicians. But when experiment has indicated the representation of quantized variables (Dirac's  $q$  numbers) on commutative fields it has not led to noncommutative algebras (Dirac, p. 146 of *op. cit.*)

If  $e^ae^b \neq e^be^a$ , then  $a + b \neq b + a$

Let  $a$  and  $b$  therefore be *quantities* at *different times* and in the sum of two dynamical variables. This would create enormous difficulties in manipulation leading to a process which further progress is impossible.

In Landé's expression for the corrections  $Z$  to the effect it is usual to substitute expressions like  $\mu_0 \frac{1}{2} \frac{d^2}{dt^2}$  (Sommerfeld, p. 690) for  $\frac{1}{2} \frac{d^2}{dt^2}$  and to do so without which is common to every such process and so to get the correct result and hope that the error would pass the eye of the teacher.

Consider now Heisenberg's velocity operator  $v_x$  in the equation

$$H = \frac{1}{2} p_x^2 + \frac{1}{2} p_y^2 + \frac{1}{2} p_z^2 - \frac{1}{r} \quad (\text{Dirac, p. 260})$$

of the motion of a free electron. We get for  $v_x$  the surprising result

$$\dot{x} = [x, H] = -cx_x.$$

It may be objected that  $\dot{x}$  is *not*  $\frac{dx}{dt}$  respectively that the  $c$  involves  $\frac{1}{2} \frac{d^2}{dt^2}$ . As we find  $\dot{y}$  and  $\dot{z}$  are similar we can conclude that a *measurement* of a component of the velocity of a free electron is *instantaneous* (as is the case for light) and that the result is the *local* conclusion easily susceptible to change when the *external field* present.

There has taken great pains to explain away this astonishing result. He asserts that the cancellation is not real though since the retarded velocity in the above conclusion is the velocity at one instant of time while observed velocities are always average velocities (measured appreciable time intervals).





with the frequency of the corresponding pumps are

$$W'_j - W'_m = h\nu_{jm}$$

$$W'_m - W'_n = h\nu_{mn}.$$

The expressions on the left hand side are additive while those on the right hand side are not (as is it physically). If the electron moves the level  $W'_m$  a distance  $\epsilon$  then the separate relations of the quantities  $\nu_{jm}$  and  $\nu_{mn}$  are unaltered. But then the effect of the electron on the level  $W'_m$  is a relation of frequency  $\nu_{jm}$  is unaltered. Now the electron may be assumed as one has to certainly at least, and there is no discontinuity between  $\nu_{jm}$  and  $\nu_{mn}$  and so not. But physically  $\nu_{jm} + \nu_{mn} \neq \nu_{jn}$ . But light quanta of  $\nu_{jm} + \nu_{mn}$  does not mean  $\nu_{jn}$ .

A word of protest must be used against the common Newtonian ideas in theories of matter and electricity. Amongst the entire range of wave mechanics, the physics of Newtonian mechanics may be viewed as a limit case of a more general theory. The classical and the wave mechanics have a common basis the four ideas of Newtonian mechanics, which are, which are, and energy are still the separate entities. In the wave mechanics theory, on the other hand, these four ideas are equivalent and they are pooled into one entity, space. The only entities appeared are the Maxwell equations and even these are not independent.

As it is fortunate that new Physics leads to a new argument. After some property has been defined in terms of assumptions, they are derived without exception, that the previous arguments may thereby be



is indicated. One such example is the case of numbers which must be integers, to which the solutions of the wave equation may be restricted, as is done in § 5. In subsequent chapters the restriction of the solutions of the wave equation to previous work.

## CHAPTER II

## WHAT IS MATTER

1. What is matter? Modern Physics assumes that it is made up of two fundamental particles—electrons and protons—plus neutrons. The two latter form the constituents of the nucleus, held together by forces believed to be extremely strong. These possess the very necessary characteristic of saturation, but Fermi and Tamm have concluded that in order to be effective the distance between the elementary particles must be of the order  $10^{-14}$ —a value much smaller than the value accepted for the diameter of a nucleus (NATURE 173, 1944). But what the structure of the fundamental particles is, modern Physics has nothing to say.

In our college days we used to play the elementary particles as something like billiard balls with a kind of push and even now we have not found a better illustration expressed by the scientific reality. Only the balls ought to slow up, but for one reason they do not. They ought to possess only the energy that has been imparted. Modern Physics has given up the search and is prepared to accept the fundamental properties—matter—as postulates without concerning itself with the question of the existence of some fundamental unity underlying them. In fact, the primary object of science is to discover unity in the midst of diversity and to reduce the number of independent fundamental

concepts to the minimum number has been given up. Science has remained essentially undecided. It is necessary only to be reminded that it is not the case that Nature makes it possible to put the question of the localization of energy in phenomena and the application of these laws to the discovery of new phenomena. We have not passed with Einstein's formulation of the type of science that is not a physical problem, but a logical one, which can be attacked only where experimentation is possible.

2. The classical physics that has submitted to a critical study is for the following fundamental problems:

(1) identification of matter with energy (Einstein); (2) localization of energy and matter and laws of propagation established by Einstein; (3) definition of gravitation as a relation of action and reaction; and (4) propagation of light as a function of time and space, expansion of distance, let us see how modern physics faces these problems.

(1) Einstein let it be known that the principle of identity of matter with energy has been generally accepted, and that it is not a matter of course, but a matter of fact, with a great many exceptions. In reality, the fact that this principle is the question of a total solution of the problem of the conversion of matter into energy was the only theory existing. The theory existed from 1905 to 1908, and was not a matter of course.

The second theory, which is the theory of the propagation of light as a function of time and space, is

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250. If the theory amounts to a postulated conservation of mass, it seems that it should immediately show that the raw materials must have had more time available in the past, so as to conform with the general fact of the existence of a large number of very old stars whose formation preceded the formation of all the stars of the present system, as shown by spectroscopic and chemical evidence.

The enormous distances between the stars and planets, generally estimated to be more than one hundred times the distance existing between the planets at high temperature. Now the circumference of the circle of the sun is about 50,000,000 kilometers, and the sun from the center of the earth to the orbit of Jupiter is 20,000,000 kilometers.

If the material from the very early stage were concentrated into a little more than one hundred miles, it is not the great part of the mass of the present sun which would contain all the main constituents and products, and therefore many times more than the very dense matter which has disappeared from view. They must have been condensed into their present form, compressed to the mass of our radiation which we know has another 200,000 times of motion and released. As the theory gives a different way for the stars to be formed, it is a very different picture of the evolution of the existing universe.

At present the theory is based on the idea of a process whereby a form of hydrogen atoms condensing to form a helium atom has come to the front. It is not the conversion of the simple mass of a hydrogen atom into a more important part of the theory.





1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

Most physicists say that the wave function is a mathematical tool, a way to calculate the probability of the location of a particle, such as an electron, at the end of a specific time interval. The way we calculate from the electron's mass, also known as its "inertia," is that it has a certain "spread" or "extension" over time and space, but a *particle*, by definition, has a location. It can't have a "spread" or "extension" because you can't find a "position" for it, so it's not a particle. It's a mathematical abstraction, a representation of what appears to have no real dimensions, but a definite "extension" over time and space. The wave function is a mathematical tool, a way to calculate the probability of the location of a particle, such as an electron, at the end of a specific time interval.

in this particularly simple case.

[illegible]



point. I think it is a mistake to regard the wave as the present position in the electron's history. It is suggested by probability waves, which may be interpreted in terms of the probability of the electron being at that point.

There is each point in the electron's path, a very intense frequency, the probability that it will be there, and it would be the place at that spot. When a wave packet of electrons is directed, the total number which may pass a point is proportional to the probability of each ray, and the sum of the probabilities of the rays is the total probability per electron.

This view may be extended to a random electron, to preserve that property. If the electron were made of waves, and a system of waves would probably be dispersed by the experiment, so that no electron particles would survive as such in any direction. In a random encounter with matter would be up electrons, which could not be regarded as permanent structures. A shower of rain, or a shower of electrons, is not the same as a shower of particles, but a shower of particles is not a shower of particles, and a shower of particles is not a shower of particles.

All this is in accordance with Heisenberg's uncertainty principle, which makes it impossible to say a particle is here at this point, and it is moving in this direction, and it is moving in this direction, and it is moving in this direction.

This is a perfectly reasonable statement. I would like to note that it is a perfectly reasonable statement.









$$\Psi = \int_{-\infty}^{\infty} f(t, r) e^{-i\omega t} d\omega \quad \Psi = \int_{-\infty}^{\infty} f(t, r, s) e^{-i\omega t} d\omega$$

It is assumed that the functions  $f$  and  $f$  are continuous in the fixed parameters which are constant in the course of integration  $\omega$ ," the complex functions  $f$  and  $f$  are assumed to be of the form

$$\left(\frac{dy}{d\omega}\right)_{\omega_0} = \omega' + \chi \frac{\omega''}{\chi}$$

Let us consider the expression  $\chi$  and assume locally  $f(t, r) = D \sin \pi r / M \leq M \cos \pi r$  and let us assume that the wave packets actually have been concentrated in the bands  $\omega_0 \pm \Delta \omega$  and  $\chi = \Delta \omega$  and  $\omega' = \omega_0 \pm \Delta \omega$ . At the instant of time  $t = 0$ , the distribution of the wave packet must be continuous, the wave packet must have a single value  $f(t, r)$  for any  $r$ . The packet of information  $\chi$  is moving through  $r$  as  $t$  increases. In respect to the continuous wave packet property of packets, we can say that  $\chi$  is a wave packet of the wave packet. We repeat that the wave packet must be a continuous process. So the wave packet is taken to represent an action that is a continuous process. It is not that a packet is only a wave packet in an unending procession.

So the packet of the wave packet is a continuous expression in the field of the continuous wave packet (pp. 10-12):—

The associated question of the wave packet is the wave packet of the field of the wave packet. The wave packet is that in it shall occupy a small volume, and it shall have a definite speed and it shall have a definite

tion of  $\lambda$ . Does it represent the velocity of an individual wave? It is not satisfactory, as given, to provide the answer. For instance, as appropriate speed of light is to be considered, it is not proper to say that the velocity of a wave is  $c$  in the vacuum, but that it decreases as it is refracted. Such a statement may be made, but it is not a satisfactory one, because it is not in a manner which is adequate to be understood in any manner. If the train is monochromatic and long enough to include many waves, it will travel with a fairly definite speed even in a dispersive medium. If it is not long enough to include several cycles, it is more properly considered as a packet of waves, or a wave packet. The group velocity of the packet is the speed of the packet, and it is this speed which is the speed of light in a dispersive medium. It is not the speed of the individual waves, but the speed of the packet. The speed of the packet is the speed of the wave packet.

It is very probable that the wave packet is not a real thing, but a mathematical concept. The wave packet is a mathematical concept. But it is not a real thing, and it is not a physical wave. It is a mathematical concept, the probability of any particle being found at a certain point in space. It is not that it is a real thing, but it is a mathematical concept. The wave packet is a mathematical concept.

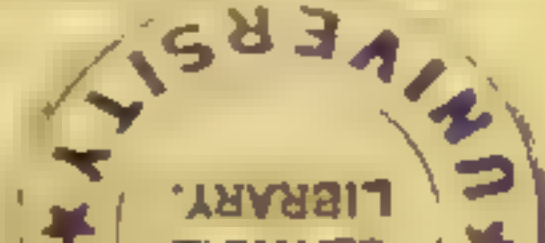
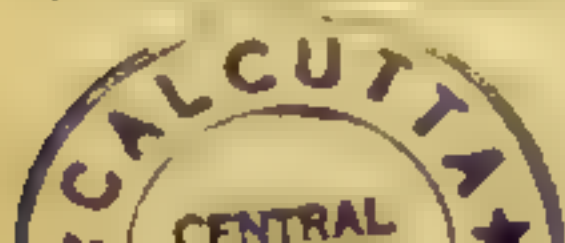
It is spite of the opinion of Kramers that the wave packet is a mathematical concept, it is not a real thing, and it is not a physical wave. It is a mathematical concept, the probability of any particle being found at a certain point in space. It is not that it is a real thing, but it is a mathematical concept.

... are physical objects, and that the wave packet is a mathematical device. The latter view can be found (p. 34):—

To interpret the spatial extension (radius) usually attributed to electrons (on the basis of the electro-magnetic theory of mass) Schrodinger preferred to represent electrons by wave packets of finite dimensions. The latter point of view is, however, contradicted by the fact that wave packets do not preserve the same dimensions, but spread out in space as time goes on, whereas the dimensions of the particles they represent are a constant.

But even so, from this, the conception of particles as wave packets contradicts the facts of observation on the interference and diffraction of the corresponding rays. For example, if a bundle of light rays is to be considered as a wave packet, then a single ray is represented by a single electron, then the scattering of these rays at a reflecting surface produces the same pattern as that produced by a pattern similar to that which is observed in the case of homogeneous light waves. In fact, to explain this interference pattern by the wave theory we must assume that the incident rays are made up of waves with a constant repetition rate, and that the scattering is due to the finite cross-section and divergence of the bundle of rays.

Thus the representation of the individual electrons as wave packets is in contradiction with the facts of observation. The only way out of this is to assume that the wave packet is a mathematical device, and that the electron is a physical object, and that the wave packet is a mathematical device.









may arise from our trying to fit a multiplicity of happenings which are not of the same dimension into a single number of dimensions. If this represents a fair cross-section of opinion, physics is not very far from the conclusion of one school of Hindu philosophy that matter is illusion, being only a manifestation of the Supreme Consciousness.

Again, the probability of an event offers no clue to the nature or character of the actors — the drama. So, even if we could know the probability of a particle's being at a certain place, we could not know the character of the particle, and could not say whether it was a proton, an electron, or a photon. It is not the probability of an event that tells us what the event is. As far as any indication about the physical structure of the particle is concerned, the probability theory is mere empty verbiage. It attempts an answer to the query "where is matter" and not "what is matter".

11. At present, it is evident that a theoretical approach to the problem of the origin of the universe is possible only in connection with the problem of the origin of the laws of nature. The solution of the problem of the origin of the laws of nature is the only way to solve the problem of the origin of the universe.

1. The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as  $\epsilon \rightarrow 0$ . It is shown that the solutions of the system (1) converge to the solutions of the system (2) in the sense of the weak convergence in the space  $L^2(\Omega; \mathbb{R}^n)$ .





The following table shows the results of the analysis of variance for the effect of the type of soil on the yield of the different varieties of wheat. The data are given in bushels per acre.

| Soil Type | Wheat Variety | Yield (bushels/acre) |
|-----------|---------------|----------------------|
| Clay      | Wheat A       | 12.5                 |
|           | Wheat B       | 10.8                 |
|           | Wheat C       | 11.2                 |
| Silt      | Wheat A       | 11.8                 |
|           | Wheat B       | 10.5                 |
|           | Wheat C       | 11.0                 |
| Sand      | Wheat A       | 10.2                 |
|           | Wheat B       | 9.8                  |
|           | Wheat C       | 10.5                 |

The analysis of variance shows that the type of soil has a significant effect on the yield of the different varieties of wheat. The yield is generally higher in clay soil than in silt or sand soil.

The first of these is the fact that the
 *Journal of the American Medical Association*
 has been the only one of the four
 leading medical journals to publish
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1. The first part of the text discusses the importance of maintaining accurate records of all transactions, including sales, purchases, and expenses. It emphasizes that proper record-keeping is essential for determining the correct amount of tax liability.

2. The second part of the text discusses the importance of understanding the tax laws that apply to the taxpayer's situation. It notes that the tax laws are complex and constantly changing, and that taxpayers should consult with a qualified tax professional to ensure they are complying with the law.

3. The third part of the text discusses the importance of paying taxes on time. It notes that failure to pay taxes on time can result in penalties and interest charges, which can significantly increase the taxpayer's overall tax liability.

4. The fourth part of the text discusses the importance of keeping up to date with changes in the tax laws. It notes that the tax laws are constantly changing, and that taxpayers should consult with a qualified tax professional to ensure they are aware of the latest developments.

5. The fifth part of the text discusses the importance of understanding the taxpayer's own financial situation. It notes that taxpayers should understand their own income, expenses, and assets, and should consult with a qualified tax professional to ensure they are taking full advantage of all available tax deductions and credits.

[illegible]







## CHAPTER III

### A NEW THEORY OF LIGHT

In the second part of the Maxwell equations, the conditions are given upon which any system of electric and magnetic forces is possible. In the present case, the conditions are the same as in the case of static forces, but the electric and magnetic forces are  $E$  and  $H$  instead of  $E'$  and  $H'$ , and the conditions may be written as

$$\text{curl } E + \frac{1}{c} \dot{H} = 0,$$

$$\text{div } H = 0,$$

$$\text{curl } H - \frac{1}{c} \dot{E} = 0,$$

$$\text{div } E = 0, \quad \dots (1)$$

and the conditions upon which any system of electric and magnetic forces is possible are

$$\nabla \cdot E = \frac{1}{c^2} \frac{d^2 F}{dt^2} = 0, \quad \dots (2)$$

where  $F$  is the scalar potential of the electric forces. In the case of static forces, the electric forces are  $E'$  and the magnetic forces are  $H'$ . In the present case, the electric forces are  $E$  and the magnetic forces are  $H$ . The conditions upon which any system of electric and magnetic forces is possible are the same as in the case of static forces, but the electric and magnetic forces are  $E$  and  $H$  instead of  $E'$  and  $H'$ , and the conditions may be written as

$$E = -\nabla F, \quad H = \nabla \times A,$$

$$F = \int \frac{1}{r} \rho \, dV, \quad A = \int \frac{1}{r} j \, dV,$$

The general solution of equations (1, 2) in one dimension of space is given by

$$E = H_z = f(x - ct) \quad \dots (4)$$

the other electric and magnetic components being zero. If this has to present the Doppler effect, it must also be a function of  $x + ct$ . In order to satisfy the wave equation we write

$$E = H_z = \phi(x - ct) \sin k(x - ct)$$

Let us determine the transformation between the coordinates  $x, t$  and  $x', t'$ . Let  $x = \beta(x' + vt')$ ,  $t = \beta(t' + vx'/c)$ ,  $\beta = (1 - v^2/c^2)^{-1/2}$ .

$$x - ct = \beta(x' + vt') - \beta c(t' + vx'/c),$$

$$\beta = (1 - v^2/c^2)^{-1/2}.$$

We have then

$$x - ct = \beta(1 + v/c)(x' - ct'). \quad \dots (5)$$

The argument of the sine function in (4) becomes  $\sin k(x - ct)$  becomes  $\sin k'(x' - ct')$ , where

$$k' = k\beta(1 + v/c) = k\sqrt{(1 - v^2/c^2)}(1 + v/c).$$

Introducing the frequency  $\nu = kc/2\pi$ , we have

$$\nu' = \nu\sqrt{(1 - v^2/c^2)}(1 + v/c).$$

This is the relativistic Doppler effect.

Thus we have shown that, in order to accept that the Maxwell equations are correct in the moving frame, provided we write

$$\mathcal{E}_x = \mathcal{H}_y = 0$$

$$\mathcal{E} = \beta F - (v/c)H_z = \beta(1 + v/c)(x - ct),$$



the same as  $\phi(x)$  in the case of a stationary observer  $O$  taking the time as  $T = x/c$ . For the same factor for the present, we thus have

$$E_p = \phi(x - ct)$$

$$E_{p'} = \psi(v'/c)E_p = \phi(x' - ct').$$

We suppose that the expression for the intensity function for a moving observer  $O'$  is  $E_{p'} = \phi(x' - ct')$  and we have a similar relation for  $O$ . Then the same as before it follows from the known relation between  $O$  and  $O'$  relative to  $O$  is

$$w = \frac{v + v'}{1 + vv'/c^2}$$

by  $T = t$  the expression for the intensity function for the observer  $O''$

$$\begin{aligned} T &= \psi(v - c)\psi(v' - c)\phi(x - ct) \\ &= \psi(w - c)\phi(x - ct) \end{aligned} \quad \dots (9)$$

is direct transformation

the expression for  $w$  is

$$w = \frac{v + v'}{1 + vv'/c^2} = c \left( \frac{v}{c} + \frac{v'}{c} \right)$$

the direct transformation

giving

$$w = c \left( \frac{v}{c} + \frac{v'}{c} \right) = c \left( \frac{v}{c} + \frac{v'}{c} \right)$$

$$E = \frac{1}{2}mv^2 = \frac{1}{2}h\nu' = \frac{1}{2}h\nu = \frac{1}{2}h\nu_0$$

$$\frac{\nu'}{\nu_0 + \nu} = \frac{1}{2} = \tanh(\theta + \theta')$$

$$\text{So } \frac{1}{2} = \frac{1}{\sqrt{1 - \beta^2}} + \frac{1}{\sqrt{1 - \beta'^2}} = \frac{1}{\sqrt{1 - \beta^2}} + \frac{1}{\sqrt{1 - \beta'^2}}$$

where  $\beta = v/c$ ,  $\beta' = v'/c$ ,  $\nu = \nu_0 + \nu'$ ,  $\nu'$  is positive or negative, integral or fractional

$$\text{Again, } \frac{v}{c} = \frac{v' + v_0}{c}$$

$$\text{or, } \frac{1 - v/c}{1 + v/c} = e^{-2\theta}$$

$$\frac{1 - v/c}{1 + v/c} = \frac{1 - \beta}{1 + \beta} = e^{-2\theta} \quad \mu = 1 - \beta$$

We have, therefore,  $\lambda(v/c) = \theta$

$$\text{or, } \psi(v/c) = e^{i\theta} = \{\beta(1 - v/c)\}^{-1/2}$$

We get, therefore,

$$E = \frac{1}{2}mv^2 = \frac{1}{2}h\nu = \frac{1}{2}h\nu_0 = \frac{1}{2}h\nu'$$

$$\text{Also, } x - ct = \beta(1 - v/c)(x' - ct')$$

Eliminating  $\beta(1 - v/c)$  we have

$$x - ct = \frac{1}{2}(x' - ct') = \frac{1}{2}(x' - ct')$$

For  $x = ct$ ,  $x' = ct'$ ,  $x - ct = 0$ ,  $x' - ct' = 0$ ,  $x = ct$ ,  $x' = ct'$ . We must have  $x = ct$ ,  $x' = ct'$ ,  $x = ct$ ,  $x' = ct'$ .

$$\text{We get } \phi(x - ct) = A(x - ct)^n$$

$$\phi(x - ct) = A(x - ct)^n \sin k(x - ct) \quad (1)$$

Let  $x = ct$ , the sine factor



There are only two values of  $t$  which can satisfy (1) for a fixed  $x$  and  $y$  and  $z$ . The first is  $x = 0, y = 0, z = 0$ .

$$E_1 = H_2 = A \sin k(x - ct)$$

this is the basis of the old classical theory which has no field independent. The other value is  $x = ct$  giving

$$E_1 = H_2 = A \sin k(x - ct) (x - ct) \quad \dots (11)$$

which is taken as the basis of our theory. The constant value of  $x$  in (11) is a constant in time, hence the vector multiple-valued.

The conclusion is, therefore, irresistible that if the Maxwell equations hold good as well as the special Relativity theory, a linear photon obeying Doppler's principle must have its electric and magnetic vectors perpendicular and in a plane perpendicular to the direction of propagation and in the form (11). There is no way of avoiding this logically unless we are obliged enough to accept the premises and deny the conclusion.

It is usual when considering any solution of the Maxwell equations to introduce the conception of a wave front (see e.g. Frankel pp. 15-16). This is a relic of Fresnel and Young's theory in which every point of the wave front was supposed to be a centre of disturbance and the wave front was supposed to move perpendicular to the ray. In the Maxwell theory the direction of propagation of the beam plays a fundamental part and the wave front is not only superfluous but misleading. If we take the Maxwell field  $E_1 = H_2 = f(x - ct)$  to cover the entire space we lose sight of the many-valued beam which is our main concern. We get in the other hand a bundle of



parallel beams in which the distribution is uniform, we get a constant pressure on the beam area, and the energy density is the same per unit volume. For this situation, if  $I = H = hc/\lambda$ , represents energy density, the energy density is the same with respect to wave length, the energy density  $g = I, z = k$ .

Consequently we put the expressions for the electric and magnetic fields in a constant electric field in the  $x$  axis by

$$E_y = Ae^{-(\lambda_1 x + \lambda_2 t)} \sin k(x - ct) / (x - ct)$$

$$H_z = Ae^{-(\lambda_1 x + \lambda_2 t)} \sin k(x - ct) / (x - ct)$$

Let us see the properties of  $g$  and  $z$ . These satisfy the Maxwell equations, the part of the beam. We obtain the pressure with the type of radiation, the wave and pressure field is expressed in the energy density. The energy of the field is that of the radiation, the energy density is (putting  $\xi = x - ct$ ),

$$\begin{aligned} & \frac{1}{8\pi} \int_0^L \int_0^L \int_0^L \left( \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2} \right) \sin^2 \frac{k\xi}{\lambda_1} d\xi d\eta dz \\ &= \frac{1}{\pi} \int_0^L \left( \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2} \right) \int_0^L \sin^2 \frac{k\xi}{\lambda_1} d\xi \\ &= \frac{1}{\pi} \cdot \frac{\pi}{8\lambda_1 \lambda_2} \left[ -\sin \frac{k\xi}{\lambda_1} \cos \frac{k\xi}{\lambda_1} + \int_0^L \sin \frac{k\xi}{\lambda_1} d\xi \right] \\ &= \frac{1}{8\lambda_1 \lambda_2} \int_0^L \left( \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2} \right) d\xi = \frac{1}{16\lambda_1 \lambda_2} \end{aligned}$$

$$\sin \frac{k\xi}{\lambda_1} \cos \frac{k\xi}{\lambda_1} = \sin \frac{k\xi}{\lambda_1} \cos \frac{k\xi}{\lambda_1}$$



Putting  $\lambda_1 \lambda_2 = 2a^2$ , we get the total electromagnetic energy as  $W = \frac{1}{2} A^2 \mu^2 k$ ,  $\mu$  having the dimension of a length.

In the first edict the electric vector was assumed to be confined to the  $xz$  plane and the magnetic vector to the  $xy$  plane. This assumption is based on the fact that the electric and the magnetic vectors are mutually perpendicular to each other and to the direction of propagation. It is in the first edict perpendicular to these planes respectively and so it is determined that it is only seen that this is the function  $\cos \frac{2\pi}{\lambda}(x - \lambda \nu t)$ .  $\lambda \nu \rightarrow c$ . The electric vector is then zero at every point outside the  $xz$  plane and the magnetic vector is zero at every point outside the  $xy$  plane. It will be convenient to work on this hypothesis. We proceed to find an expression for the energy.

The energy of a unit volume of matter is  $\frac{1}{2} \epsilon E^2$  and the kinetic energy of a unit volume of matter is  $\frac{1}{2} \rho v^2$ . The total energy of a unit volume of matter at any instant is given by

$$\frac{1}{2} \epsilon \int_{-\infty}^{\infty} E_y^2 d\tau.$$

Let us take the volume of propagation to be  $\xi = x - ct \rightarrow \infty$  and  $\eta \rightarrow 0$ . We assume that the electric vector is confined to  $\xi$  parallel to  $a$ . The total energy of the matter in the propagation at any instant is then given by  $\frac{1}{2} \epsilon \int_{-\infty}^{\infty} E_y^2 d\xi$  ( $\xi = x - ct$ ).

$$W = \frac{1}{2} \mu^2 \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E_y^2 d\xi d\tau = \frac{1}{2} \frac{a}{c} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E_y^2 d\xi d\tau.$$

$$= \frac{1}{2} \left[ \frac{1}{2} \left( \frac{1}{2} \right) + \int_0^1 \frac{1}{2} \right]$$

$$A = \frac{1}{\pi} \int_0^{2\pi} \left( \sum_{n=0}^{\infty} c_n e^{-in\theta} \right) d\theta$$

The factor  $p_{\text{eff}}$  is the effective probability of a polymer chain being selected for a comparison of a length

$$+ 2\pi \cdot k_1 + 3\pi \cdot k_2, \dots$$

For a lattice of  $N$  sites,  $\mathbf{r}$  and  $\mathbf{r}'$  are the sites of the  $i$ th and  $j$ th atoms, respectively. For  $\mathbf{r} = \mathbf{r}'$ ,  $\mathbf{U}_i = \mathbf{U}_i^0$ , with  $\mathbf{U}_i^0$  the on-site interaction. The hopping  $t$  is assumed to be nearest-neighbor, and  $\mathbf{r}$  and  $\mathbf{r}'$  are assumed to be nearest neighbors. The hopping  $t$  is assumed to be positive, and the lattice possesses the conventional definition of a pulse,  $\mathbf{r} = \mathbf{r}' + \mathbf{a}$ , where  $\mathbf{a}$  is a lattice vector. For  $\mathbf{r} = \mathbf{r}' + \mathbf{a}$ ,  $\mathbf{U}_i = \mathbf{U}_i^0 + \mathbf{U}_i^1$ . Since the presence of a velocity of light  $c$  is apparent in the distribution of  $\mathbf{r}$  and  $\mathbf{r}'$ , we have to take into account the wave vector  $\mathbf{k}$  in the definition of

where  $\omega$  is the wave number,  $\lambda = 2\pi/\omega$ ,  $\nu = v/\lambda$  is the frequency of the exposure,  $t = t_0 + (t - t_0) \exp(-t/t_0)$  is the exposure,  $t_0 = 1/2\pi$  and the photoenergy

$$B = (1 - \mu^2)L \quad \text{for} \quad \text{where} \quad \mu = 1 - \alpha - \beta$$

we get an expression for the impulse we note that the Maxwell equation is being now evaluated at the path of the beam. Poynting's theorem is modified. An expression may be derived as follows. Consider the energy density



where  $\mathbf{r}$  is the surface vector  $\mathbf{r}$  and is given by  $\mathbf{r} = \rho \mathbf{e}_r + z \mathbf{e}_z$ . Since  $\mathbf{x}$  and  $\mathbf{t}$  enter only in the combination  $\mathbf{r} - \mathbf{t}$

$$\frac{\partial}{\partial t} = -\frac{\partial}{\partial x}$$

$$H = \frac{1}{8\pi} \iiint F^2 d\mathbf{r}, \quad \text{where } F^2 = \mathbf{F} \cdot \mathbf{F}.$$

$$\frac{dH}{dt} = -\frac{c}{4\pi} = -\frac{1}{8\pi} \frac{\partial}{\partial x} \iiint F^2 dx d\mathbf{r}$$

$$= -\frac{1}{8\pi} \iiint \frac{\partial F^2}{\partial x} dx d\mathbf{r} = -\frac{1}{8\pi} \iint F^2 \cdot \mathbf{F} \cdot d\mathbf{a}$$

integrating along a thin rod parallel to the  $x$ -axis,  $x_2$  and  $x_1$  being the  $x$ -coordinates of the ends of the rod,

$$= -\frac{1}{8\pi} \int F^2 dS$$

in the surface  $F$  being the  $x$ -direction cosine of normal.

Thus the rate of increase of energy within the surface  $S$  is equal to the rate of flow of  $cF^2/8\pi$  across the surface in the direction of the  $x$ -axis. The flowing vector for the speed of light is proportional to the wave

$$S_x = \frac{c}{8\pi} A^2 \frac{\sin^2 k\xi}{\xi^2}.$$

Similarly for the negative energy  $-F^2/8\pi$  it is  $-S_x$ , therefore,

$$\frac{1}{4\pi} \iiint \frac{\sin^2 k\xi}{\xi^2} c_\xi^2 dx d\mathbf{r} = \frac{F_0}{4}$$

More simply, we assume the packet of the Relativity theory,

$$mc^2 = h\nu$$

the impulse

$$mc = h\nu/c,$$

5.  $k = 2\pi/\lambda = 2\pi/\hbar c = 2\pi/\hbar \nu = 2\pi/\hbar mc$

5. It is obvious that the expression

$$\frac{1}{2\pi} \int_0^{2\pi} \cos k\xi d\xi = \frac{1}{2\pi} \int_0^{2\pi} \cos k\xi d\xi$$

represents a packet of simple harmonic waves, has the same value as the expression

It is extremely significant that the expression which has been derived from the Maxwell equations with an eye on the Relativity considerations alone, should stand for a packet of simple harmonic waves. It is evident that the expression is not a simple harmonic wave, but a packet of simple harmonic waves. It is evident that the packet is not a simple harmonic wave, but a packet of simple harmonic waves. It is evident that the packet is not a simple harmonic wave, but a packet of simple harmonic waves.

The integral

$$\frac{1}{2\pi} \int_0^{2\pi} \cos k\xi d\xi$$

can be written in the form of a packet of simple harmonic waves

$$\left\{ \int_0^{2\pi} \cos k\xi d\xi \right\} = \left\{ \int_0^{2\pi} \cos k\xi d\xi \right\}$$

For this is a simple harmonic wave packet, it can be written in the form of a packet of simple harmonic waves

$$\cos k\xi = \cos k\xi$$





superpose on it another wave of the equation

$$E_{y1} = H_{y1} = A \sin k_1 \xi / \xi$$

and superpose on it another

$$E_{y2} = H_{y2} = -A \sin k_2 \xi / \xi$$

and so on. The total energy of the wave and matter is given by the expression

$$\begin{aligned} W &= \frac{A^2 \mu^2}{4\pi} \int_{-\infty}^{\infty} \left( \sin k_1 \xi / \xi + \sin k_2 \xi / \xi \right)^2 d\xi \\ &= \frac{A^2 \mu^2}{2\pi} \int_0^{\infty} \left( \frac{\sin k_1}{\xi} + \frac{\sin k_2}{\xi} \right)^2 \xi d\xi = \frac{A^2 \mu^2}{2\pi} \int_0^{\infty} \left( \sin^2 k_1 \xi / \xi + \sin^2 k_2 \xi / \xi + 2 \sin k_1 \xi \sin k_2 \xi / \xi \right) d\xi \\ &= \frac{A^2 \mu^2}{4} \left( k_1 + k_2 \right) + \frac{A^2 \mu^2}{2\pi} \left[ -\frac{\cos (k_1 + k_2) \xi}{\xi} + \cos (k_1 - k_2) \xi \right]_0^{\infty} \\ &= \frac{A^2 \mu^2}{4} (k_1 + k_2) + \frac{A^2 \mu^2}{2\pi} \left[ -\frac{\cos (k_1 + k_2) \xi}{\xi} + \cos (k_1 - k_2) \xi \right]_0^{\infty} \\ &= \frac{A^2 \mu^2}{4} (k_1 + k_2) + \frac{A^2 \mu^2}{2\pi} \left\{ \frac{1}{k_1 + k_2} - \frac{1}{k_1 - k_2} \right\} \\ &= \frac{A^2 \mu^2}{4} (k_1 + k_2) + \frac{A^2 \mu^2}{2\pi} \left\{ \frac{1}{k_1 + k_2} - \frac{1}{k_1 - k_2} \right\} \end{aligned}$$

where  $k_1 = k_1 + 2\pi$  and  $k_2 = k_2 + 2\pi$

It is clear that the contribution which may be added to the energy of the photon is that the difference of the energy of the two complete photons. It is easily verified that the



the spectrum is produced by wave packets of different wavelengths, the same wave length  $2\pi/\lambda$  is produced extremely mixed up together. The difference is that while the complete photon possesses a finite energy  $h\nu$ , the partial photon possesses only infinitesimal energy proportional to  $\delta k$ . In experiments involving the energy and momentum of light, as for example, in the photoelectric effect and the energy distribution in the spectrum, it is the complete photons of energy  $h\nu$  which preponderate. While in experiments on wave length the partial photons of small energy  $\delta k$  are complete photons of  $\nu_0$  energy  $h\nu_0$  to which they are put in continuity and are connected by the momentum and do not show a partial position.

$$A \int_{k_1} \cos k\xi dk$$

and so the beam is a very narrow one, but it contains waves by being passed through a prism, a complete photon

$$A \sin k\xi \xi$$

is emitted as a wave packet of  $2\pi/k$  goes straight unaffected. Unusually narrow beams have a certain amount of support in the following passage, only to be up.

As a first step toward the formulation of such a description we observe that as a photon travels along  $z$ , it is in connection with rather definite properties which are conveniently described by a continuous point of view. In particular, it gives to the velocity of sound waves when all the waves are continuous medium. It might be described in structure as a wave. We must expect this to be most evident in the present case and

[illegible][illegible]

7. Hence, the above evidence from the accepted view that the energy of a system at light of frequency  $\nu$  is  $h\nu$ . It is a consequence of the Einstein relation which has been shown in Computer 1 that  $h\nu$  is over-energetic.

One consequence of that the two quantities have to be combined physically is not that the particle picture is wrong. It may well be verified experimentally if we had some means of direct test from the Quantum Mechanics. The particle picture is unsatisfactory because the particle and wave properties are subjects of two different phenomena and cannot be put in the same context. The simultaneous determination, in our view, of this postulate is easily understandable, because the two entities are distinct.

So it may be proved that the equation of the partial photon shells is simply a particular case of the total length of a spectrum line. It is expressed

$$L \sin k = \sin I_k \xi = \int_{\lambda}^{\infty} \sin I_k d\lambda$$

where  $\lambda$  is continuous range of wave frequency waves are not discrete but the values are only approximately wave length  $\lambda$  and  $\sin I_k$  is not constant of the time. When  $\xi$  is very large the expression tends to zero.

It may be further noticed that a very simple form of waves is no different from any one of other one. So if we consider particularly the radiation of a photon in the form of a train of superluminous waves we have to be more careful of our calculations. For example we may have to specify that the pump of an electron from one energy level to another in a hydrogen atom will not radiate in a continuous wave of constant length. Otherwise a infinite train of waves once started will go on forever. The expression  $\sin I_k \xi = \int_{\lambda}^{\infty} \sin I_k d\lambda$  solves the difficulty as it tends to zero as  $\xi \rightarrow \infty$  and when  $\xi \rightarrow 0$ .



Again, if in the train of simple harmonic waves  $1/4h$  are  $h\xi$  possessing energy proportional to the square of the amplitude, only the energy of the wave is reversed in sign, the phase remains unaltered, and the frequency is the same. This gives a complete mathe-

matical picture of the process followed in producing interference bands, where a beam of light is split up into two halves and made to recombine after one of them has been retarded.

The following summary picture of the process of interference is due to a paper by Lord Rayleigh, and is not far from the actual physical conditions actually involved. The two surfaces of the mirror which reflect the two portions of the mirror respectively must, therefore, be separated by a path of the same length as the distance of the surface of the mirror from the point of observation. As this distance is not practically the same, a compensating arrangement is necessary. So the path difference between the two waves in the interference experiment must be made to zero.

Another important consequence of the wave theory is connected with the polarization of light, which has been mentioned in connection with the interference of light, and is of the Maxwell electromagnetic theory.







$$\frac{1}{r} \left\{ \frac{\partial}{\partial r} (ru_r) - \frac{\partial u_r}{\partial \phi} \right\} \dots (1)$$

(Love, p. 56)

Let us assume that the velocity is small so that

$$\frac{1}{\omega} \frac{\partial \psi}{\partial \phi} = -\frac{1}{c} \frac{\partial \psi}{\partial t} \quad ; \quad \frac{u_r}{\omega} = \frac{1}{c} \frac{\partial \psi}{\partial t} \dots (2)$$

$$\frac{1}{r} \frac{\partial E_r}{\partial \phi} = 0, \quad \frac{1}{r} \frac{\partial r H_\phi}{\partial \phi} = 0$$

and the other two equations reduce to the following two

$$\frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial \psi}{\partial r} \right) = \frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2} \quad ; \quad \frac{\partial^2 \psi}{\partial r^2} = \frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2}$$

which are the wave equations for the scalar potential  $\psi$  and the vector potential  $A$ .

It is not difficult to see that the solutions of these equations are of the form  $\psi = f(x - ct)$  and  $A = g(x - ct)$  where  $f$  and  $g$  are arbitrary functions of their arguments. This is the case for the wave equation in one dimension.

Let us now assume that the wave is a plane wave moving in the  $x$  direction. Then the potential  $\psi$  is a function of  $x - ct$  only. The electric field  $E_r$  is given by  $E_r = -\frac{1}{r} \frac{\partial \psi}{\partial \phi}$  and the magnetic field  $H_\phi$  is given by  $H_\phi = \frac{1}{r} \frac{\partial (r A)}{\partial \phi}$ . The electric field is perpendicular to the magnetic field and both are perpendicular to the direction of propagation.

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$$E_r = A \sin k(x - ct) \quad ; \quad H_\phi = A \cos k(x - ct)$$

where  $A$  is the amplitude of the wave. The electric field is perpendicular to the magnetic field and both are perpendicular to the direction of propagation. The wave is a plane wave moving in the  $x$  direction. The potential  $\psi$  is a function of  $x - ct$  only. The electric field  $E_r$  is given by  $E_r = -\frac{1}{r} \frac{\partial \psi}{\partial \phi}$  and the magnetic field  $H_\phi$  is given by  $H_\phi = \frac{1}{r} \frac{\partial (r A)}{\partial \phi}$ . The electric field is perpendicular to the magnetic field and both are perpendicular to the direction of propagation.



It is important to note that the above results are based on the assumption that the system is in a steady state. In practice, the system may be in a transient state, and the results may differ. However, the above results provide a useful approximation for many practical applications.

It is a common error to understand the various parts of the human body as separate and distinct, by the influence of which the human mind is enabled to perform its various functions. The human mind is a unity, and the only way to understand it is to consider it as a whole, by which it is enabled to perform its various functions. It is probable that the human mind is a unity, and the only way to understand it is to consider it as a whole, by which it is enabled to perform its various functions. The human mind is a unity, and the only way to understand it is to consider it as a whole, by which it is enabled to perform its various functions.

It is not difficult to expect that more experiments will be done in the near future to solve this problem. It does not seem to be necessary to assume that the interaction between the regular and chaotic motions is continuous, that the first interaction can be accepted as the start of the electromagnetic wave of frequency  $\omega$  possesses finite energy and impulse. But it does not solve the present theory. If the energy is finite, the diffraction efficiency is to be supposed to be caused by complete non-perturbations,  $\omega_{\text{max}} \ll \omega$ . But, the power

be considered as a continuous wave of frequency  $\nu$ . The phenomenon of diffraction is then explained by the diffraction effect.

(1) One of the important consequences of this theory is that the frequency of the wave is proportional to the energy of the electron. This is in agreement with the experimental results obtained by Planck and Einstein. The frequency of the wave is given by the equation  $\nu = \frac{E}{h}$ , where  $E$  is the energy of the electron and  $h$  is Planck's constant. This equation is in agreement with the experimental results obtained by Planck and Einstein. The frequency of the wave is given by the equation  $\nu = \frac{E}{h}$ , where  $E$  is the energy of the electron and  $h$  is Planck's constant. This equation is in agreement with the experimental results obtained by Planck and Einstein.

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$$E = h\nu$$

$$\nu = \frac{E}{h} = \frac{8\pi^2 mc^4}{h^2} \quad \dots (2)$$

$$\text{The period } T = \frac{2\pi}{\omega} = \frac{h^2}{4\pi^2 mc^4} \quad \dots (3)$$

and the frequency of the electron in orbit is  $\frac{1}{T}$

(Sommerfeld, p. 706)

$$\nu = \frac{2\pi mc^4}{h^2} \quad \dots (4)$$

The energy levels are given by the equation  $E_n = -\frac{13.6}{n^2}$  eV, where  $n$  is the principal quantum number. This equation is in agreement with the experimental results obtained by Planck and Einstein.

$$\lambda = \frac{c}{\nu} = h \left( \frac{1}{n^2} - \frac{1}{m^2} \right)$$





It is a natural consequence of the above. On Bohr's theory Einstein's derivation of the red shift has no meaning. The energy of a photon belongs to the class of partial photons of energy  $h\nu$  and the fall of the energy level to another, is made up by the number of photons emitted.

If to the above equation, Bohr's formula is a handy rule of thumb for determining frequency without its illogical consequences.

If  $1/\epsilon$  and the charge  $e$  are known, we have to apply Gauss' theorem that the total normal induction is  $4\pi$  times the charge enclosed.

$$\Phi = \int N dS$$

The normal induction  $N$  is given by the charge  $q$  regarded as surface density.

Replace the ends of our model by thin strips of breadth  $\delta$ , so as to cover the entire spherical surface. We spread out the surface into  $l$  strips of width of the strip. The normal induction thus  $\delta$  and the elementary area  $ada$ . We have, therefore,

$$\Phi = \int N dS = \int \frac{l}{\delta} da = 4 \int_0^\pi \frac{e \sin \theta}{\delta} \delta d\theta = 4\pi e$$

This gives the value of  $1/\epsilon$  as  $4\pi e$  for the electron. We have also the expression for  $1/\epsilon$  as  $1/8\pi e$ . We get the value of  $e$  as  $1/32\pi$ . But the main interest

of the result lies in the fact that the figure is a constant and independent of  $e$  which determines the mass of



where  $p$  is the momentum. Thus for one value of  $p$ , the sign of  $E$  may be either positive or negative.

\* The acceleration of a positive electron in excited states give rise to various difficulties. The acceleration of such an electron due to an external force is in the opposite direction of the force, i.e. in the direction of the magnetic field. It would be a contrary electron but would not be a real electron as it has no mass and no charge. It is a pure mathematical concept and cannot be said to be valid.

It would not be surprising if the results were more consistent for the more homogeneous groups, to the extent that the more homogeneous groups were more homogeneous with respect to the dependent variable. It is not possible in the present data to test this possibility. The degree of heterogeneity of the groups can be expected

[illegible][illegible]



states, the lower ones  $n=1, 2, 3, \dots$  will be occupied, and the rest  $n=4, 5, 6, \dots$  will be occupied. If, for a moment, we imagine the Coulomb field switched on adiabatically, a certain number of electron pairs would thus be created, which means that the vacuum could be polarised by an electromagnetic field.

As the number of electron pairs created increases, the number of holes (positrons) also increases, and the charge of the system becomes positive. Since, however, the potential energy is only  $\sim 2mc^2$  per electron pair, it is only for  $n=1, 2, 3, \dots$  that the presence of the field is appreciable,  $\sim \frac{1}{2}mc^2 \sim \frac{1}{2}h\nu$ , or, equivalently, in the range  $\lambda \sim 2.4 \times 10^{-12}$  cm. If the field is not too high a value,  $\sim 10^{18}$  v/cm, it is

thus calculated that the number of the pairs at equilibrium is determined by the number of holes,  $n$ , created. The rest of the pairs are created by the action of the same processes which are described in principle according to the above considerations. In the latter case, however, we have to take the transition

8. We may now make a rough idea of the size of the electron pair. The size we mean is the Compton momentum  $h/2\pi (\sim mc\lambda)$ .

We get again  $\lambda \sim 2.4 \times 10^{-12}$  cm, and therefore we are led to say of the mass holes that they are of the order of  $10^{-36}$  g.  $\times 10^{-10}$  cm. The hypothesis is, however, not yet described. It may be supposed that with a clustered model, the electron pair formed by the interaction would be the subject of a complex



Consider an electron moving with velocity  $v$  relative to an observer  $O$  with its axis perpendicular to the direction of motion. The apparent frequency of the electromagnetic wave is also determined by the electron's motion relative to its plane parallel to the direction of  $v$ . At the extremities of the electron's diameter the Doppler effect is determined by the apparent frequencies

$$\lambda_1(1 - v \cos \alpha/c), \quad \lambda_2(1 + v \cos \alpha/c).$$

The mean frequency is, therefore,

$$\lambda(1 - v^2/c^2).$$

As the electron is thus completely transverse the Doppler effect is transverse and the apparent frequency is not affected by  $v$ . At an intermediate point  $P$  the electron will not be at right angles to the line of sight and the apparent frequency will be the sum of the transverse and longitudinal effects. At the position  $P$  the electron is at distance  $r$  from the observer and the distance  $OP$  is  $r \cos \alpha$ . The Doppler effect is  $\lambda_1(1 - v \cos \alpha/c)$  and  $\lambda_2(1 + v \cos \alpha/c)$ . The transverse effect is  $\lambda(1 - v^2/c^2)$ . The frequency at  $P$  is the mean of these three effects, i.e.  $\lambda(1 - v^2 \cos^2 \alpha/c^2)$ . The frequency at the other extremity of the diameter is  $\lambda(1 - v^2 \sin^2 \alpha/c^2)$ . The mean of these two is

$$\lambda(1 - v^2 \cos^2 \alpha/c^2).$$

The frequency at the other extremity of the diameter is  $\lambda(1 - v^2 \sin^2 \alpha/c^2)$ .

$$\lambda(1 - v^2 \sin^2 \alpha/c^2).$$



the mass from  $m$  to  $m'(1-v^2/c^2)^{1/2}$  to the same order of approximation

Consider a body moving parallel to the moving frame with velocity  $v$ . The proper length of the body is  $l_0$ . The velocity of the body parallel to the direction of the velocity of the frame is  $u$ . The quantity  $l_0 u$  from eq. (1) is  $l_0 u$  in the mass  $m = m_0(1-v^2/c^2)^{-1/2}$ . The mass  $m$  is a constant quantity, formula (1) cannot account for the variation of  $l_0$  as observed.

The present paper is devoted to deal with a question that is not yet fully solved, to explain it. What is suggested here must be taken very tentatively.

It is well known that matter as a whole is very much smaller than the Coulomb field. Because two electrons are  $4.7 \times 10^{-14}$  and  $2.2 \times 10^{-14}$  m distant from the nucleus of  $2 \times 10^{-14}$  m and the mass of the nucleus is  $6 \times 10^{-27}$  kg,  $8.1 \times 10^{-17}$  kg and  $1.8 \times 10^{-17}$  kg respectively. It will be recalled that a picture of the nucleus is that a proton of mass 1840 times that of an electron, the size is about of the nucleus where a great part of the mass is concentrated. Although the matter is much smaller than the field at different distances from the nucleus.

The shell of electrons tends to be formed around the nucleus gradually. Therefore, these electrons are the kind of force very heavy in number, it is true, but still



the same. The same is true of the other parts of and the whole of matter. The whole of matter is the repetition of the elements and the interaction of elements because atoms is permanent. The whole of matter is regarded as the *body* of the whole of matter. The whole of matter is a permanent body. The whole of matter is the whole of the whole of matter.

## SUMMARY AND CONCLUSIONS

Since the  $\mathcal{A}$ -module  $\mathcal{A}[\mathcal{A}]$  is a free  $\mathcal{A}$ -module, we have  
 an isomorphism of  $\mathcal{A}$ -modules  $\mathcal{A}[\mathcal{A}] \cong \mathcal{A} \otimes_{\mathcal{A}} \mathcal{A}$ . The  
 previous proposition then implies that the natural map  
 $\mathcal{A}[\mathcal{A}] \otimes_{\mathcal{A}} \mathcal{A} \rightarrow \mathcal{A}[\mathcal{A}]$  is an isomorphism.

$$F_1 = H_1 = 1 \text{ on } h(x-ct) \leq (x-ct)$$

[illegible][illegible]

*[Faint, illegible handwritten notes]*

As we have seen, the latter reduces to the former if

$$\lim_{\lambda \rightarrow 0} \frac{1}{\lambda} \left( \frac{\partial f}{\partial x_i} - \frac{\partial f}{\partial y_j} \right) = 0.$$

[illegible]

It is also important that the method used to calculate the pressure is interpreted. The concept of pressure is familiar. So are Maxwell equations and the Planck distribution. However, the new method of calculation of the Planck distribution is equivalent to the photons interacting with a thermal reservoir. The physical properties of the system are not the same as in the case of a black body. As a result, the pressure becomes one of the physical properties. The pressure then becomes one of the quantities that can be experimentally verified. As a physical property, the pressure is a vector which leads to further assumptions of physical laws, but the pressure is not a total derivative. What is essential is that the energy of the photon field is represented by a continuous density



here we have been brought face to face with the charge. Only the density of charge has no meaning in our theory of discrete charges. It may also be pointed out that the two divergence equations of Maxwell are rather difficult to interpret when we leave the old classical standpoint of continuous distribution. The theory of charge is only a re-iteration of the Maxwell equation  $\text{div } E = \rho$ . Only this equation is very often lost sight of and the charge treated as if it was a part of the fundamental concept of matter instead of being only a derived property. Moreover, all the fundamental particles, electrons, positrons, neutrons and protons are placed on the same footing, their different masses being due to the different range of frequencies of waves in their composition. The different signs of the charges are explained by the opposite direction of the electric vector. Mesons also fall in line with the scheme, possessing varying masses but possessing, as far as can be ascertained, the same charge. If the theory is correct, pair production is not due to the conservation of the charge, but to the conservation of angular momentum.

3. Another interesting feature of the new theory is that the radiation from an electron when there is a transfer from one energy level to another, comes from the corpus of the electron itself. It will be recalled that the Bohr theory of the spectrum which runs right through the Quantum Mechanical theory of radiation is based on the Newtonian conception of potential energy. But the Relativity theory has introduced a new conception of field of force. According to the latter, in free space, the distance between two neighbouring points in the four dimensional



continuum of space and time is given by the equation

$$\begin{aligned} ds^2 &= c^2 dt^2 - dx^2 - dy^2 - dz^2 \\ &= c^2 dt^2 - dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2, \end{aligned}$$

the signs on the right hand side being a matter of convention. It is quite permissible to take the time with the negative sign and the space coordinates with the positive. But if a particle of mass  $m$  is introduced at the origin, the metric is altered to

$$ds^2 = -\left(1 + \frac{2m}{r}\right) dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2 + c^2 \left(1 - \frac{2m}{r}\right) dt^2.$$

The space may be supposed to have been distorted by the introduction of the particle and the gravitational force is only the apparent consequence of this distortion.

That the Relativity theory mixes up the potential and the kinetic energies can easily be seen from the following example: consider the mass of a particle at rest to an observer  $O$ . If this observer has a velocity  $v$  with reference to another observer  $O'$ , the mass of the particle to the latter in energy units is  $m_0 c^2 / (1 - v^2/c^2)^{1/2} = m_0 c^2 + \frac{1}{2} m_0 v^2$ . The second term represents the kinetic energy of classical mechanics which has been introduced by a change of position of the observer himself.

In fact, the idea of a field of force as a vector field is, strictly speaking, foreign to the basic idea of the Relativity theory, but has to be used for progress and must be regarded as an approximation. The Relativity mathematics, except for the simplest problems, is extremely complicated. As Eddington has remarked, the problem of two bodies remains yet a challenge to the relativistic mathematician in much



the same way as the problem of three bodies to the classical mathematician.

The idea of radiations emanating from the corpus of the electron is, broadly speaking, more in conformity with the Relativity theory than Bohr's idea based on the classical Newtonian potential. It presents again a more satisfactory means of conveyance of excess energy than Fermi's neutrinos.

A tentative explanation may be offered here for the non-absorption of radio waves by matter. The power of absorption of radiation by electrons, on the present theory, depends on the "hunger" of these electrons for the special radiations. If a large number of electrons are lacking in certain waves in their composition, they will readily absorb radiations of that wave length. Thus visible light is readily absorbed by all matter, while metals with a large number of free electrons absorb radiations more freely than non-conductors. Radio waves can penetrate thick walls because these radiations are usually not missing from the composition of the electrons and are thus transmitted without change. This property, therefore, depends not so much on the amount of energy of the radiations but on the "hunger" of the electrons for those radiations.

Lastly, Lorentz transformation gives the longitudinal and transverse Doppler effects. This gives, on the basis of our model of the electron, the Relativity variation of mass which has hitherto been regarded as a postulate. There is no theory extant which even attempts at an explanation.

4. Why photons of certain wave lengths should have the tendency to form coils, some stable others unstable,



we have no idea. The reason can only be understood when we have better insight into the interaction between the different parts of the photon and a more complete picture of their structures. There must be a number of knotty points which will have to be settled before the theory can be regarded as fully established. But if it can stand these tests, modern Physics will have been brought down from the clouds to the base but solid earth. If simplicity be one of the tests of truth, we hope it will be agreed that our model of the fundamental particles has greater claim to recognition than the nebulous and intangible abstractions of modern Physics.

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